

4130 vs 4140 vs 4142 vs 4330 Sucker Rod Material Comparison

API 11B Rod Pumping Reference | Cr-Mo and Ni-Cr-Mo Alloy Systems | Chemistry, Strength Tendency, Heat Treatment Response and Traceability

Scope and reading rule

This reference compares four alloy steel families often discussed for sucker rods and related rod-string components. The comparison is based on chemistry, hardenability, strength-toughness tendency and inspection relevance. Final API 11B sucker rod acceptance still depends on finished-rod grade, tensile testing, heat treatment records, thread inspection, coupling compatibility and heat / lot traceability.

Important distinction: 4130, 4140, 4142 and 4330 identify material families. They do not replace API 11B grade control. A finished sucker rod must still be verified by mechanical properties, thread condition, marking and document records.

Material family	Alloy system	Typical chemistry focus	Sucker rod material tendency	Main review point
4130 / 4130M	Cr-Mo low alloy steel	C 0.28-0.33%; Cr 0.80-1.10%; Mo 0.15-0.25%	Balanced hardenability, toughness margin and heat-treatment response.	Verify grade, tensile strength and thread records; do not read 4130 as a finished rod grade.
4140 / 4140M	Cr-Mo medium-carbon alloy steel	C 0.38-0.43%; Cr 0.80-1.10%; Mo 0.15-0.25%	Higher carbon gives higher strength / hardness potential after heat treatment.	Control hardness consistency, toughness margin and fatigue-sensitive thread areas.
4142 / 4142M	Cr-Mo medium-carbon alloy steel	C 0.40-0.45%; Cr 0.80-1.10%; Mo 0.15-0.25%	Often reviewed as a higher-strength Cr-Mo route for alloy rod applications.	Check heat treatment records, tensile range, hardness and marking consistency.
4330 / 4330M	Ni-Cr-Mo alloy steel	C 0.20-0.30%; Ni 1.00-1.50%; Cr 0.40-0.60%; Mo 0.30-0.50%	Nickel-bearing alloy system for higher strength-toughness demand.	Verify heat treatment, toughness-related records, coupling fit and heat-lot traceability.

Data note: composition ranges are typical reference ranges for AISI/SAE material families. Modified sucker rod grades such as 4130M or 4330M may follow manufacturer-specific chemistry windows and should be checked against the MTC.

Chemical composition matrix

Chemical composition explains the material route. Carbon controls strength and hardness response. Chromium and molybdenum support hardenability and tempering behavior. Nickel in 4330 changes the alloy system and improves toughness potential compared with 41XX Cr-Mo grades.

Element / function	4130 / 4130M	4140 / 4140M	4142 / 4142M	4330 / 4330M	Meaning for sucker rod review
Carbon, C	0.28-0.33%	0.38-0.43%	0.40-0.45%	0.20-0.30%	Higher carbon increases hardening response and strength potential, but toughness control becomes more important.
Chromium, Cr	0.80-1.10%	0.80-1.10%	0.80-1.10%	0.40-0.60%	Supports hardenability and through-section strength consistency.
Molybdenum, Mo	0.15-0.25%	0.15-0.25%	0.15-0.25%	0.30-0.50%	Improves hardenability and tempering resistance; higher Mo in 4330 supports high-performance heat treatment.
Manganese, Mn	0.40-0.60%	0.75-1.00%	0.75-1.10%	<= 1.00%	Contributes to strength and hardenability; variation affects heat-treatment response.
Silicon, Si	0.15-0.30%	0.15-0.30%	0.15-0.30%	<= 0.80%	Works as a deoxidizer and contributes to strength.
Nickel, Ni	Not intentional	Not intentional	Not intentional	1.00-1.50%	Helps toughness and strength-toughness balance in Ni-Cr-Mo alloy steel.
P / S	P <=0.035%; S <=0.040%	P <=0.035%; S <=0.040%	P <=0.035%; S <=0.040%	Controlled by specification	Residuals should be kept low to reduce harmful effects on toughness and fatigue behavior.

Sucker rod material review should connect chemistry with heat treatment and finished-rod mechanical results. The chemistry matrix is the starting point; tensile strength, hardness consistency, thread inspection and heat / lot traceability confirm the finished rod identity.

Material tendency in sucker rod service

Sucker rods work under repeated tensile load. The rod body, pin end, shoulder area and coupling connection form one load path. As strength potential rises, technical review should move beyond rod-body tensile strength and focus on fatigue-sensitive connection details, heat-treatment consistency and traceable records.

Material family	Technical tendency	Relevant sucker rod conditions	Records that matter most
4130 / 4130M	Balanced Cr-Mo material route with lower carbon than 4140 / 4142.	Moderate load rod strings where hardenability, toughness and machinability need balance.	Heat chemistry, tensile result, hardness review, thread inspection, MTC.
4140 / 4140M	Higher-carbon Cr-Mo route with stronger hardening response.	Rod or polished-rod components where higher strength / wear resistance is expected.	Heat treatment record, hardness consistency, straightness, thread and coupling fit.
4142 / 4142M	Higher-carbon Cr-Mo material often linked with Grade D alloy-type rod references.	Moderate-to-high load rod-string sections in non-corrosive or effectively inhibited service.	Tensile strength range, hardness, thread inspection, marking consistency.
4330 / 4330M	Ni-Cr-Mo route with added toughness potential and higher alloy cost.	High-strength or special alloy rod applications where toughness and fatigue resistance are emphasized.	Chemical heat, heat treatment, tensile / hardness records, coupling compatibility, heat-lot traceability.

From 4130 to 4142
Carbon rises from about 0.30% in 4130 to about 0.40-0.45% in 4142. This increases hardening response and strength potential, while making toughness and hardness control more important.

What 4330 changes
4330 adds nickel and uses a Ni-Cr-Mo system. It is normally reviewed for strength-toughness balance, fatigue-sensitive service and tighter documentation control.

Selection and inspection checklist

This comparison should be used as a material-screening reference, not as a final design rating. Finished sucker rod acceptance depends on API 11B grade, mechanical test results, heat treatment, thread / coupling interface and traceability.

Review item	Why it matters	Recommended record
Material designation	Confirms whether the rod uses 4130M, 4140M, 4142M, 4330M or another modified alloy route.	MTC, heat analysis, material specification
API 11B grade	Defines finished rod strength category; material name alone does not define final grade.	Grade certificate, tensile test report
Heat treatment	Converts chemistry into final strength, hardness and toughness balance.	Heat-treatment record, hardness review
Mechanical properties	Verifies that tensile / yield performance matches the intended strength level.	Tensile result, yield result, elongation where reported
Thread and coupling interface	Fatigue risk is concentrated at pin end, shoulder contact and coupling fit.	Thread inspection, coupling record, visual report
Traceability chain	Links physical rod to heat, test data, marking and bundle identity.	Rod marking, heat / lot map, packing list

One-line technical summary

Material	Short technical reading
4130	Balanced Cr-Mo starting point: lower carbon, useful heat-treatment response and better toughness margin.
4140	Higher-carbon Cr-Mo step with stronger hardening response and closer hardness / toughness control.
4142	Higher-carbon Cr-Mo route often used where higher Grade D alloy strength is required.
4330	Ni-Cr-Mo route where nickel supports toughness potential and higher-performance rod applications.

Document focus: material chemistry -> heat treatment -> mechanical testing -> thread / coupling inspection -> heat-lot traceability. This is the practical chain for reading alloy steel sucker rod material data.